DOCUMENT RESUME

ED 142 964 CS 003 602

AUTHOR Vargha-Khadem, F.; And Others
TITLE Cerebral Asymmetry for Verbal and Nonverbal Sounds in Normal Literate and Illiterate Children.
PUB DATE Mar 77
NOTE 20p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (New Orleans, Louisiana, March 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Auditory Perception; *Cerebral Dominance; *Child Language; Children; Elementary Education; Foreign Countries; *Illiteracy; Language Research; *Neurological Organization; Perceptual Development; Psychological Studies; *Sex Differences
IDENTIFIERS *Dichotic Listening; Iran

ABSTRACT

A preliminary experiment was conducted to explore the effects of illiteracy on hemispheric specialization. Groups of literate and illiterate Iranian children were tested on three dichotic tapes consisting of monosyllabic animal names, double-digit numbers, and nonverbal environmental sounds. All children were also tested for handedness and for auditory acuity. Results indicated a significant overall right ear advantage for both verbal tapes on measures of accuracy and order of recall. The right ear advantage varied as a function of sex and literacy: literates and females demonstrated significantly higher accuracy rates than did illiterates and males, on both verbal tapes. In the case of the nonverbal tape, literate males and illiterate females demonstrated a left ear advantage both on accuracy and on order of recall measures. (Author/AA)

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CEREBRAL ASYMMETRY FOR VERBAL AND NONVERBAL SOUNDS IN NORMAL LITERATE AND ILLITERATE CHILDREN[1]

F. Vargha-Khadem, F. Genesee, M. R. Seitz[2] & W. E. Lambert

McGill University

The notion that the acquisition of literacy skills may have an influence on the development of cerebral asymmetry is not new. As early as 1904, Weber proposed that cerebral dominance for language was actually determined by the development of reading and writing skills. More recent speculation (Geschwind, 1972; Sperry, 1973; Bogen, 1975) suggests that the emphasis of the Western educational system on the acquisition of verbal-analytical skills may contribute to the development of left hemisphere predominance, while leaving the right hemisphere "untrained" in its functions.

Despite interest in relating the effects of formal education to cerebral organization, very few controlled investigations on the matter have been reported, and their results are equivocal. Thus, in a recent study, Damasio, Castro-Caldas, Grosso and Ferro (1976) reported that illiterate, brain damaged adult patients demonstrate the same type and proportion of aphasic syndromes as do literate, brain damaged patients. However, another report which classified subjects on the basis of level of literacy indicates that the frequency of occurrence of aphasia was significantly reduced in both semi-literate and illiterate groups compared to control literate subjects (Cameron, Currier and Haerer, 1971).

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Further, a case report (Wechsler, 1976) of an illiterate right-handed patient indicates the development of a persistent non-fluent aphasia following a right cerebral infarction.

From a developmental viewpoint, no empirical evidence on the relationship between hemispheric specialization and acquisition of literacy skills exists. This may be due partly to the fact that cases of complete illiteracy among children in most Western cultures are confounded with physiological, intellectual, emotional and/or severe social-environmental deficits. It is difficult to relate cerebral organization to illiteracy in such cases given the concomitant multiple problems. In contrast, illiterate populations from cultures were formal education is not available on a large scale, nor necessarily valued, provide suitable subjects for this type of research.

Given the scarcity of empirical findings, it is difficult to predict what influence illiteracy would have on cerebral lateralization. As a result, the current study was not designed to test specific hypotheses. Rather it represents a preliminary attempt to explore hemispheric specialization in normal illiterate children using the dichotic listening technique.

By far the majority of dichotic experiments involving children demonstrate only left hemisphere specialization for language functions. In fact, there is only one report of right hemisphere superiority for the processing of non-verbal sounds in young children (Knox and Kimura, 1970). In this experiment we

tested for both left and right hemisphere specialization in both our experimental and control groups.

METHOD

Setting

Testing was conducted in the small village of Zavieh, situated 80 kilometers south west of the city of Tehran, Iran. For the most part, the inhabitants of this village have a rural background. Approximately 80% of the adult population of Zavieh is completely illiterate. Education for children has become free and compulsory during the past decade, but the traditional custom of training young children for various trades still prevails. Thus, many children do carpet weaving or work on farms rather than go to school.

Subjects

Two groups (N = 16 each) of literate and completely illiterate children were selected from the general population of Zavieh. Mean age for the literate group was 10.2 years (range 8 to 12 years) while that of the illiterate group was 11.5 years (range 8 to 13 years). The literate group was divided equally between the two sexes; the illiterate group was comprised of 10 females and 6 males. All female illiterate children were carpet weavers while the male illiterates worked on farms or tended herds.

All the literate children had received between 3 and 5 years of formal education (mean number of years of schooling -

4.06). For inclusion in the literate sample, subjects were required to write their names and a few simple sentences and to read two passages from their school textbook.

The children in both groups were selected with the help of local teachers who, having lived and taught in the village, were familiar with the level of education of the literate children and the background of the illiterate children. All children were right-handed, had adequate hearing and had no known deficits. Hand preference was determined by a modified version of the Edinburgh Handedness Inventory.

Test Materials and Apparatus

Three dichotic tapes consisting of monosyllabic animal names, double digits from 1 to 10 (excluding digit 4), presented in the Persian language, and non-verbal environmental sounds were prepared. For each tape, 10 pairs of stimuli were recorded and then recorded once more on opposite channels, thus making a total of 20 pairs of counterbalanced stimuli matched for intensity and onset time. Each pair of stimuli occurred the same number of times and equally often in each ear. On both verbal tapes, there was a 10 sec. inter-trial interval. In the case of the double digits, there was a .5 sec. interval between each pair of digits. The non-verbal stimuli were each .4 sec. long with a 10. sec. inter-trial interval.

The three tapes were played on a two-channel, stereophonic, Sony taperecorder. All stimuli were presented to the children

through stereophonic headphones. The tapes were recorded with a two minute dichotic calibration tone of 1000 Hz which permitted adjustment of the two channels to equal intensity levels.

Procedure

Subjects were tested individually in the common room of the village center, where an electrical outlet was located. Prior to presentation of the dichotic tapes, the children were pre-tested on a monaural version of each tape to ensure both adequate hearing and accurate recognition of all stimulus material.

For the two verbal tapes the children were told that they would hear 20 pairs of words or numbers presented stimultaneously, one to each ear. They were required to listen to the stimuli and to repeat what they had heard in any order, during the 10 sec. inter-trial interval.

In the case of the non-verbal tape, a pointing-to-pictures procedure (Knox & Kimura, 1970) was adopted in order to minimize the possible involvement of the left hemisphere in verbalizing the response. Thus, the children were required to listen to each pair of sounds and then point to two pictures depicting the sounds they had heard. For each pair of sounds an array of six pictures was presented; two of these were targets and the remaining four distractors.

Headset positions were counterbalanced across subjects so that half the subjects had the earphones in straight position (i.e., channel 1 in left ear) while the other half in reversed position (i.e., channel 1 in right ear).

Results

Two measures were used to assess ear asymmetry: accuracy and order of recall. Accuracy of recall was determined by calculating, separately for each ear, the number of stimuli correctly recalled from each ear as a proportion of the total number of stimuli presented to each ear. Percentage scores were then derived from these proportions. For the order of recall measure, the number of left ear and right ear input stimuli recalled first was calculated. Once again, a proportion of the total number of stimuli correctly recalled first for each ear was derived and then transformed into a percentage score. Unlike the accuracy of recall scores, the order of recall scores for the two ears were not independent of one another and added up to 100%. Thus, only one of the two ear scores were included in the analysis of variance. On the double digits tape, order of recall measure was based on the first digit correctly recalled on each trial.

Separate analyses of variance were performed on the accuracy and order of recall measures for each of the three tapes.

Tape 1: Monosyllabic Words

An analysis of variance was performed on the accuracy of recall scores for the dichotic words to determine the effects of literacy (literate, illiterate), sex (male, female), and ear of input (left, right).

Figure 1

A significant interaction of sex x ear was found indicating virtually no difference between ears in accuracy of recall for male subjects (M left ear = 79.06; M right ear = 80.0); however, in the case of females, accuracy of recall was greater in the right than in the left ear (M left ear = 74.81; M right ear = 83.0), $F(1,23) = 4.30$, $p < 0.05$.

Figure 2

A significant interaction of literacy x sex indicated that literate males had greater accuracy of recall (M = 84.37) compared to literate female (M = 76.31). In the case of illiterate children, females demonstrated greater accuracy of recall (M = 81.50) compared to males (M = 74.63), $F(1,23) = 7.38$, $p < 0.01$.

Figure 3

The literacy x sex x ear interaction was marginally significant. This interaction indicates that whereas literate males did not demonstrate an ear asymmetry (M left ear = 83.95; M right ear = 85.0), literate females had a pronounced right ear advantage (M left ear = 68.12; M right ear = 84.50). Illiterate children did not demonstrate differential accuracy of recall scores between ears, regardless of sex (M males LE = 75.0; RE = 74.39; M females LE = 81.50; RE = 81.50), $F(1,23) = 3.80$, $p < 0.06$. The only significant effect found in the analysis of order of recall scores was that of ear, indicating an overall right ear advantage (M LE = 41.20, RE = 58.80) $t(31) = 3.68$, $p < 0.01$.

Tape 2: Double Digits

Analysis of accuracy of recall scores on the double digits tape indicated an overall right ear advantage (M LE = 73.28; RE = 80.85), $F(1,23) = 8.22$, $p < .008$. Similarly, analysis of order of recall scores indicated an overall right ear advantage (M LE = 42.52, RE = 57.48), $t(31) = 3.32$, $p < .01$. In addition, a significant interaction of sex x ear was found indicating a greater right ear advantage for females (M = 63.50) compared to males (M = 51.50) in order of recall.

Figure 4

Tape 3: Non-Verbal Environmental Sounds

The analysis of accuracy scores indicated a significant three way interaction for literacy x sex x ear.

Figure 5

Thus, literate males (M LE = 77.50; RE = 68.75) and illiterate females (M LE = 76.0; RE = 70.0) were found to demonstrate a left ear advantage in the processing of non-verbal sounds. However, both literate females (M LE = 62.50; RE = 73.0) and illiterate males (M LE = 67.50; RE = 75.0) showed a right ear advantage, $F(1,23) = 17.39$, $p < .0003$. Analysis of order of recall scores also indicated the same significant interaction of literacy x sex x ear.

Figure 6

Thus, stimuli presented to the right ear were reported first more often than stimuli presented to the left by literate females (M LE = 41.12; RE = 58.88) and by both illiterate males (M LE = 37.87; RE = 62.13) and females (M LE = 42.90; RE = 57.10). However, there was virtually no difference between the ears in order of recall for the literate males (M LE = 49.25; RE = 51.75), $F(1,23) = 6.40$, $p < .01$.

Discussion

With respect to the verbal tapes, the overall right ear advantage in accuracy and order of recall indicated left hemispheric specialization for the processing of language in the sample studied. To this extent, these results are consistent with those based on children tested in Western cultures. However, both sex and literacy factors seem to influence the demonstration of ear asymmetry. Thus, females showed a stronger right ear superiority than males who showed virtually no difference between ears in accuracy of recall. Further, literate females demonstrated the greatest right ear advantage, greater than that of literate males and both illiterate males and females.

In terms of overall accuracy of recall, literate males were found to have higher scores than literate females and both illiterate males and females.

That the literate females demonstrated a greater right ear advantage than males while the literate males demonstrated greater overall accuracy than females is in contrast to data reported on

children tested in Western cultures. Whereas females from Western cultures have been reported to show more overall expressive verbal ability (McCarthy, 1954), they demonstrate lateralization of hemispheric functions at a later age compared to male children (Witelson, 1974; Knox and Kimura, 1970). The present results suggest that cultural factors may have to be considered in interpreting possible differences between the sexes on measures of overall verbal ability and hemispheric asymmetry.

With respect to the non-verbal tape, it should be noted that it is a more complex task to demonstrate a left-ear advantage for non-verbal sounds in children. Specifically, it is difficult to eliminate completely the possibility of non-verbal stimuli being coded verbally and at the same time maintain a reasonable level of occurate stimulus identification. In view of these points and the fact that an overall left ear advantage for the processing of non-verbal sounds was not found on our tape, we do not feel confident to draw firm conclusions about right hemisphere functions on the basis of our findings.

In conclusion, we have been encouraged by these preliminary results. They suggest to us that literacy and sex factors may have a differential influence on the development of cerebral asymmetry. We are pursuing this question further by studying children and adults with different levels of literacy.

REFERENCES

Bogen, J. E. Some educational aspects of hemispheric specialization. UCLA Educator, 1975, 17, 24-32.

Cameron, R. F. Currier, R. D., & Haerer, A. F. Aphasia and literacy. British Journal of Disorders in Communication, 1971, 6, 161-163.

Damasio, A. R., Castro-Caldas, A., Grosso, J. T., & Ferro, M. J. Brain specialization for language does not depend on literacy. Archives of Neurology, 1976, 33, 300-301.

Geschwind,N. Disorders of higher cortical function in children. Clinical proceedings. Children's Hospital, National Medical Centre, 1972, 28, 261-272.

Knox, G., & Kimura, D. Cerebral processing of non-verbal sounds in boys and girls. Neuropsychologia, 1970, 8, 227-237.

McCarthy, D. Language development in children. In Manual of Child Psychology, L. Carmichael (Ed.), New York: John Wiley, 1954.

Sperry, R. W. Lateral specialization of cerebral function in the surgically separated hemispheres. In McGuigan, F. J. (Ed.), The Psychophysiology of Thinking. New York: Academic Press, 1973.

Weber, E. Das Schreiben als Ursache der Linseitigen Lage des Sprachcentrums. Orig. Mitteilunger, Zentral Blad fur Physiologie, September, 10, 1904.

Wechsler, A. F. Crossed aphasia in an illiterate dextral. Brain and Language, 1976, 3, 164-172.

Witelson, S. F. Hemispheric specialization for linguistic and nonlinguistic tactual perception using a dichotomous stimulation technique. Cortex, 1974, 10, 3-17.

FOOTNOTES

1. This research was supported by a Canada Council Doctoral Fellowship (W76 3333) to F. Vargha-Khadem, and by a grant from the Department of Education, Quebec, to F. Genesee and M. M. Seitz.

2. Currently at the Department of Human Communication Disorders, Dalhousie University, Halifax, Nova Scotia.

3. The authors wish to thank Dr. Larry Mononen for his technical assistance in preparing the dichotic tapes. Special thanks are due to Dr. P. Homayunpoor, Miss Modoni and Mr. Noori of the Women's Organization of Iran, for their assistance in locating and testing children.

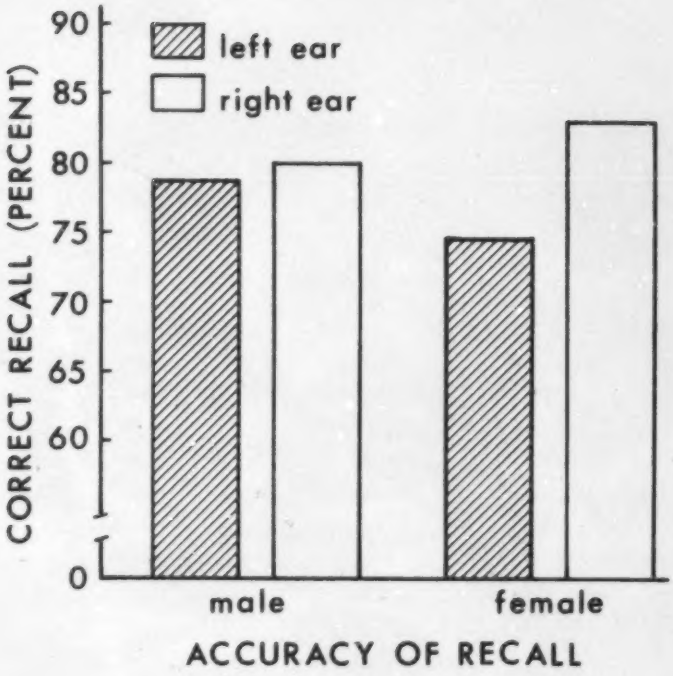
90
85
80
75
70
65
60
0
left ear
right ear
CORRECT RECALL (PERCENT)
male
female
ACCURACY OF RECALL

Figure 1

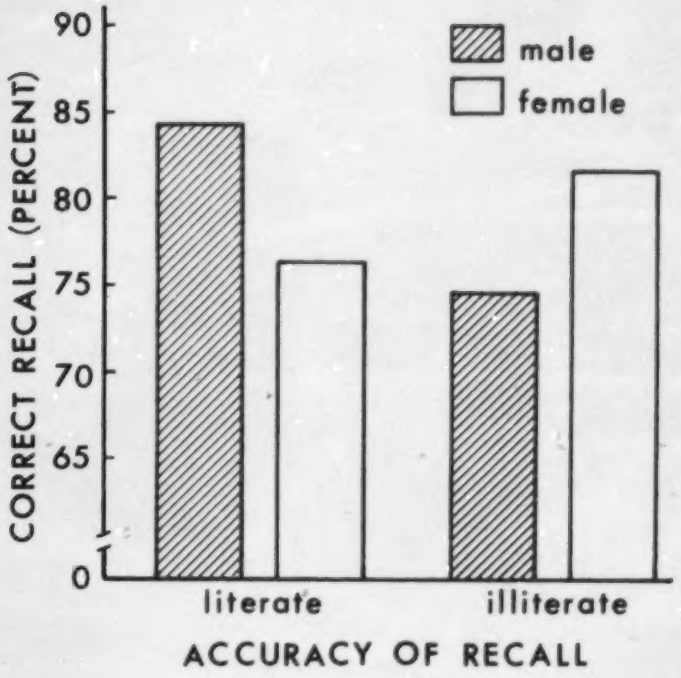
90
85
80
75
70
65
0
CORRECT RECALL (PERCENT)
male
female
literate
illiterate
ACCURACY OF RECALL

Figure 2

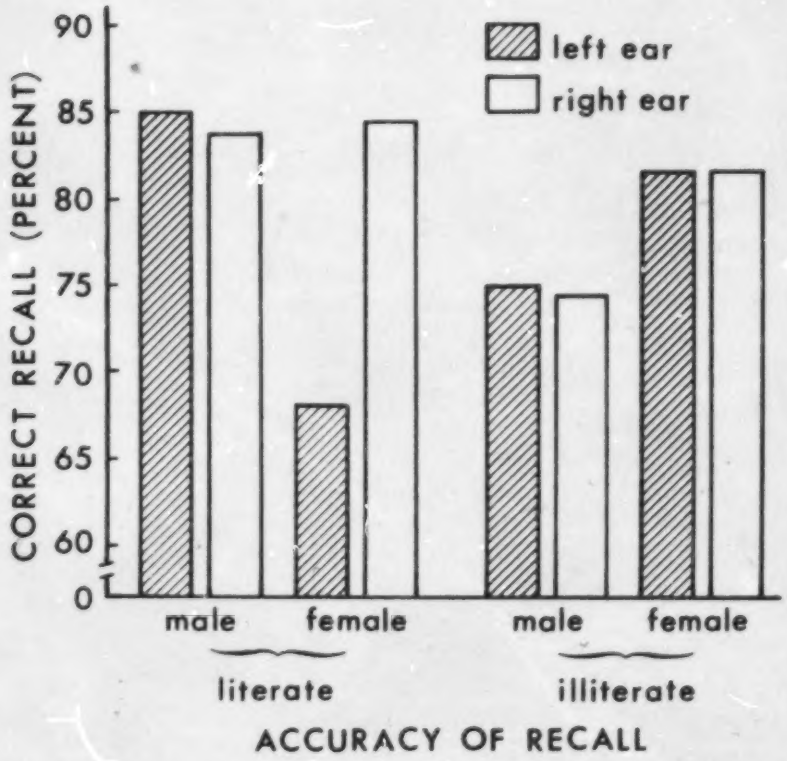
90
85
80
75
70
65
60
0
CORRECT RECALL (PERCENT)
left ear
right ear
male
female
male
female
literate
illiterate
ACCURACY OF RECALL

Figure 3

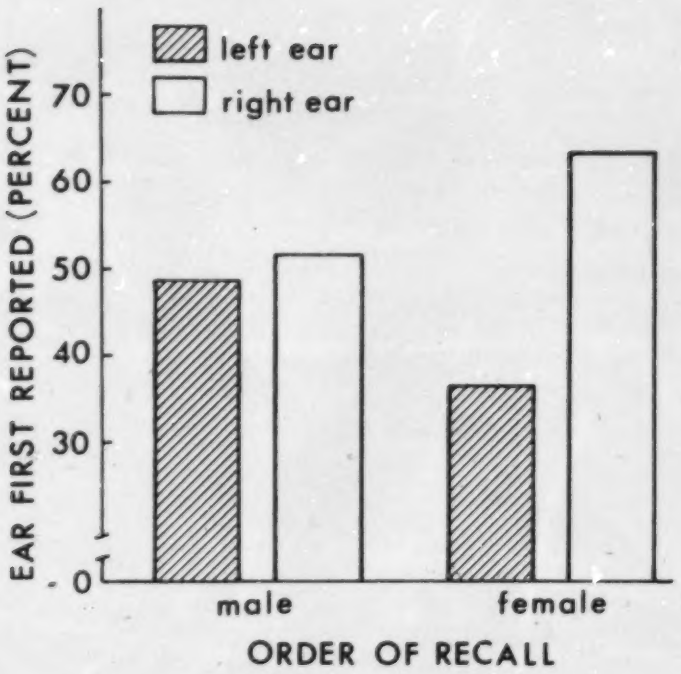
left ear
right ear
EAR FIRST REPORTED (PERCENT)
70
60
50
40
30
0
male
female
ORDER OF RECALL

Figure 4

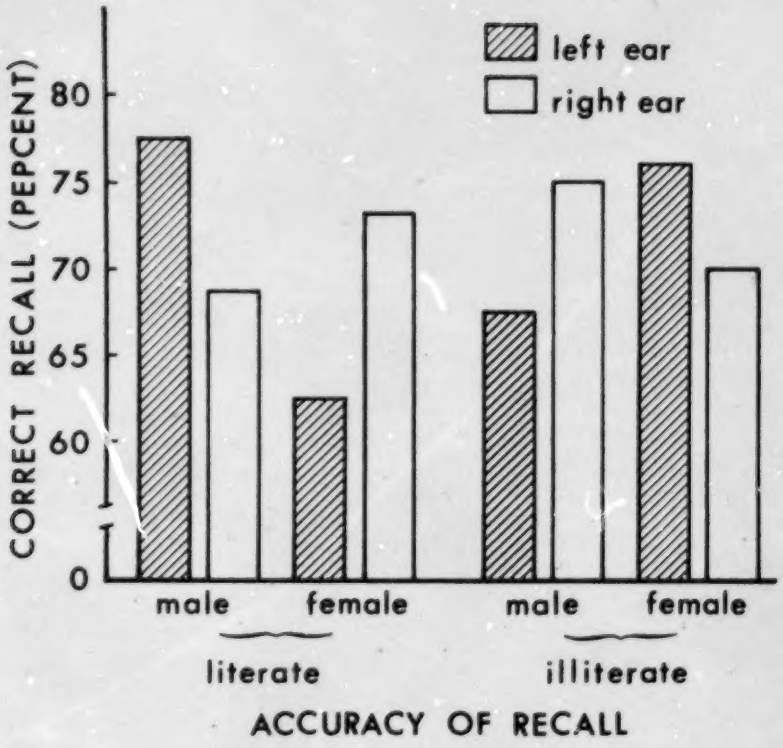
left ear
right ear
CORRECT RECALL (PEPCENT)
80
75
70
65
60
0
male
female
male
female
literate
illiterate
ACCURACY OF RECALL

Figure 5

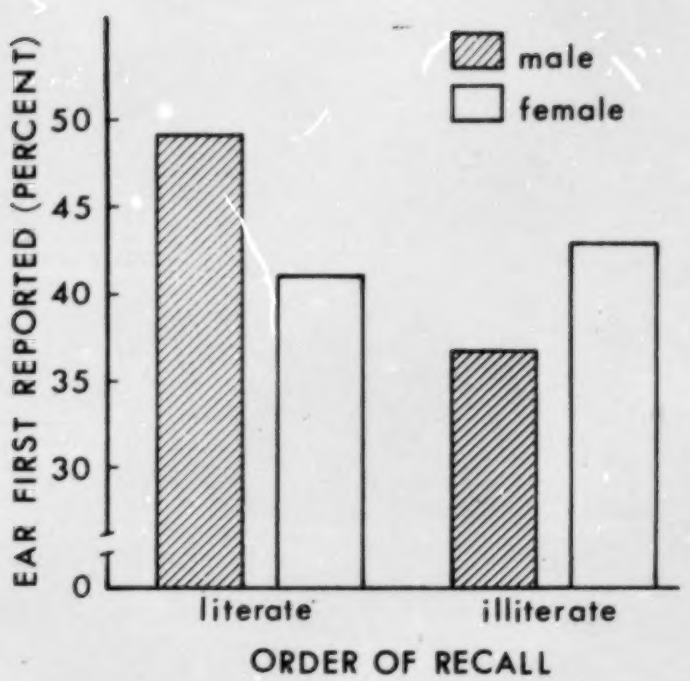
male
female
EAR FIRST REPORTED (PERCENT)
50
45
40
35
30
0
literate
illiterate
ORDER OF RECALL

Figure 6